P R O C E E D I N G S

April 22, 1997 3 p.m.

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(The following proceedings were reported by Suzette Moschella:)

THE COURT: While we're waiting, that last lettered exhibit which I said was Defendant's CC is really Defendant's P; is that correct?

THE CLERK: Right.

THE COURT: Is the record correct on all of that now?

MR. CRIST: Your Honor, I have no objection with respect to the document itself, but it's beyond the scope of cross.

THE COURT: Are you objecting for it to be moved into evidence?

MR. CRIST: Examination with respect to it yes, Your Honor, I do intend to object. And I don't have a copy of that document, so --

THE COURT: May I see it?

MR. MOTLEY: Yes, sir, I was handing it to the clerk to give you.

THE COURT: Is there some specific part that you're offering?

MR. MOTLEY: Yes, sir, let me get you the

part. Here.

THE COURT: Let me see if I can find this here. Judge, it's this sentence right here. The first sentence. It's tagged.

THE COURT: The first sentence in the second paragraph.

MR. MOTLEY: The one that's got a little red thing beside it.

THE COURT: Okay.
MR. MOTLEY: Judge, I'll tell you what, I'll save time and move on. I've got one more question and I'm done. I don't want you to have to read that whole thing. I'll just use it tomorrow.

BY MR. MOTLEY:

Q You were asked about Alka-Seltzer?
A Yes.
Q And the use of a cartoon character?
A Yes.
Q Dr. Pollay, to your knowledge, has Alka-Seltzer been accused of causing lung cancer?
A No.
MR. CRIST: Objection, Your Honor.
THE COURT: Sustained.
MR. MOTLEY: No further questions.

THE COURT: Any recross, Mr Crist?
MR. CRIST: Yes, Your Honor, very briefly.

RECROSS EXAMINATION

BY MR. CRIST:

Q Dr. Pollay, you were asked on redirect examination about what has been marked as Plaintiff's Exhibit 39; do you remember that?
A Yes.
THE COURT: It's 49.
A 39 doesn't register. The content or the title?
MR. CRIST: Your Honor?
THE COURT: I believe I changed that to 49.
MR. CRIST: You're right.
Q Let me show you, Dr. Pollay, 49.
MR. CRIST: I didn't catch the change, Your Honor.
Q Do you recall the portion of this document that you brought to the attention of the jury on page 2, Dr. Pollay? Do you remember that?
A Yes.
Q Dr. Pollay, isn't it true that this entire document is evaluating a new concept which would be a high nicotine -- comparatively high nicotine versus tar cigarette, that's what this document's about,

isn't it?
A No, this isn't about cigarettes at all. This is about nicotine delivery systems that are other than cigarettes, gum, mouthwashes candy, etc.
Q And what this portion of this document, Dr. Pollay, is discussing is what consumers' attitudes or understandings are with respect to nicotine, correct?
A Yes, that's part of it. And to the extent to which they see nicotine as the villain or tar as the villain.
Q And, Dr. Pollay, the author of this document concludes, he not, that a lot of people think that nicotine is bad, and that's why they don't understand, isn't it?
A Yes, that's part of the confusion.
Q The entire document is premised upon the conclusion of the '64 Surgeon General Advisory

Committee report that nicotine does not have -- cause any dangerous functional changes, isn't it?
A I don't know that. I don't see any reference in here to the '64 Surgeon General's report.
Q But it's to the same concept, isn't it, that people do not understand that nicotine had, in this and other contexts, been found not to have -- or to cause any dangerous functional changes; isn't that

correct?
A I can't vouch for that. I mean, I can only tell you what this study is.
Q The fundamental point of this study, Dr. Pollay, was that a lot of people thought that nicotine was bad, but the author was saying the evidence doesn't support that, right?
A I don't see the author saying that. They certainly do point out the consumer confusion in here.
Q And the consumer confusion was that more people thought nicotine was bad than this author thought was appropriate, isn't that the conclusion of this document?
A I don't remember that being the conclusion, but that may be a -- told of the document.
Q Dr. Pollay, let me turn now to another topic, if I can. Mr. Motley showed you a couple of sentences out of what has been marked as Plaintiff's Exhibit 50; do you remember that?
A Again, the 50 doesn't ring a bell to me.
THE COURT: Show him the document.
MR. CRIST: Do you have it, sir? I think he has it, Your Honor.
A If you would give me the title.
MR. CRIST: May I approach?

THE COURT: Yes.
BY MR. CRIST:
Q Dr. Pollay, the first time -- strike that.
This is a document which you also have in your archives, right?
A Yes.
Q It's a document you have in your archives because somebody sent it to you in an anonymous envelope with no return address on it, right?
A That's correct.
Q Now, Dr. Pollay, this document was sent to whom? Who did this document go to? Strike that.
Let me back up. Who within R. J. Reynolds Tobacco Company was the addressee of this document?
A There is no distribution list on the document.
Q Who within R. J. Reynolds Tobacco Company received a copy of this document, Dr. Pollay?
A As I say, there is no distribution list on the document.
Q And the fact of the matter is that not only is there no distribution list on this document, but you don't know if anybody ever received it, do you?
A That's correct.
Q And in addition to that, Dr. Pollay, what

you do know is that unlike the document you received in the anonymous envelope, this document has "draft" on it, doesn't it?
A Yes, it does, on page one, it says, Draft.
Q Now, the fact of the matter is that you have never seen any R. J. Reynolds Tobacco Company documents that are convergent with this; isn't that right?
A Well, I've seen other R. J. Reynolds documents that also talk about youth targeting.
Q You have never seen any documents that are convergent with this, have you?
A I'm not sure what you mean by convergent, but I've seen other R. J. Reynolds documents that talk about youth targeting.
MR. CRIST: Your Honor, move to strike on the basis it's nonresponsive.
MR. MOTLEY: He asked what convergent --
A That seems convergent to me.
Q You have no idea, Dr. Pollay, whether this document --
MR. CRIST: I'm sorry, Your Honor, I apologize.
THE COURT: Why don't you do this, withdraw the question and put it to the witness and to the

Court with another word than "convergent," because I don't know what that means either.
MR. CRIST: Okay. I'll do that, Your Honor.
BY MR. CRIST:
Q You have no idea, as you sit here today, whether or not this ever became part of any R. J. Reynolds Tobacco Company policy, do you?
A That's correct.
Q And you have no idea, as you sit here today, Dr. Pollay, whether or not this draft memorandum, which has no distribution list and which, as far as you know, was not sent to anybody, was ever acted on either, do you?
A Except for the documents we've seen earlier about the research tracking studies of 14 to 17-year-olds that was going on at the same period of time?
MR. CRIST: Your Honor, I move to strike on the basis it's nonresponsive.
THE COURT: Motion is granted. The jury will disregard. Please answer the question that is put to you, sir.
BY MR. CRIST:
Q The question that was put to you, Dr. Pollay, is that as you sit here today, you have no

idea whether or not this draft document, which has no distribution list and which, as far as you know, was sent to nobody, was ever acted on by R. J. Reynolds Tobacco Company; isn't that true?
A I guess that's true in the narrow sense.
Q It's true not only in the narrow sense, it's true in the absolute sense, isn't it?
MR. MOTLEY: Judge, if he's asking a

question like that, he ought to be allowed to answer.

THE COURT: He hasn't answered.

A I don't know what to do except repeat myself. I mean, in the same period of time they are doing studies of the youth market, the behavior of 14 to 17-year-olds which seems to be convergent with this.

THE COURT: We've abandoned the word "convergent."

Let me say this, if a question is asked of you and you don't understand the question, then ask the lawyer to repeat the question or put it into terms that you can understand, and then answer the question. But if you don't understand the question, don't just answer any old question, answer -- ask him to reask -- the lawyer to

rephrase.

BY MR. CRIST:

Q You were deposed in this case, were you not, Dr. Pollay?

A Yes.

Q And do you recall on October 15th, 1996, your deposition was taken and you were sworn?

A Yes.

Q And with respect to this document, do you recall giving these questions to these answers --

MR. MOTLEY: You means these answers to these questions?

MR. CRIST: That's what I mean.

MR. MOTLEY: I don't object then, Judge.

MR. CRIST: Maybe if I read them backwards.

BY MR. CRIST:

Q "Where did you get that document?

"Answer, I don't recall. It's known generally as the Teague memorandum offered in 1973.

"Question, It's marked confidential, isn't it?

"Answer, Yes, it is.

"Question, And you have no recollection of where you received this document from?

"Answer, This document's in broad

circulation.

"Question, Have you ever seen a copy of it with the stamp "draft" on the top?

"Answer, No, I have not.

"How long have you had this document?

"Answer, I don't recall. I don't recall, but a year or so, something like that.

"Question, Do you know who Mr. Teague is?

"I believe he was a part of the research department.

"Question, What do you know about the background of this document or why it was prepared?

"Answer, Well, only that which is obvious within the document. I have no other documents convergent on this.

"Question, Do you know whether this was ever part of Reynolds' policy or that Reynolds ever acted

on this document?
"Answer, No, I do not."
Did you give those answers to those questions?
A Yes, I did.
MR. CRIST: Your Honor, give me one second.
THE COURT: Yes.
THE CLERK: I don't have an Exhibit 50.

THE COURT: Hold on a second. You've referred to this as Plaintiff's Exhibit 50?
MR. CRIST: No, Your Honor, I was referring to it as -- yes, Your Honor it is Plaintiff's Exhibit 50. This is the one --
THE COURT: The clerk says he has no --
MR. CRIST: This is the one Mr. Motley is to redact.
THE COURT: Okay. I understand. Do you understand?
THE CLERK: Yes, sir.
MR. CRIST: Your Honor, I have no further questions.
MR. MOTLEY: I just have a couple.
THE COURT: All right.

FURTHER REDIRECT EXAMINATION

BY MR. MOTLEY:
Q This is the one he was asking you about, see that?
A Yes, sir.
Q Correct? The mystery, the one that you don't know where it came from?
A Yes.
Q It's a mystery where it came from, right?
A Well, in terms of how I obtained my copy.

It's was authored by Mr. Teague.
Q Is it signed by Mr. Teague?
A Yes.
Q Here's one that's in evidence, this is Number 19. Does it have the same logo, RJR Confidential?
A Yes, it does.
Q Same format?
A Yes, it does.
Q Same page numbers down the side, these numbers on the side? Right there.
A Yes.
Q Each one has got the same -- different numbers, but the same numbering system?
A Yes.
Q Same court order stamp?
MR. CRIST: Your Honor, I object, this is belaboring the obvious. This witness is not more qualified than anybody else to do this.
MR. MOTLEY: Judge, he suggested -- may I be heard on this?
THE COURT: I'll permit you to go on a little bit more.
MR. MOTLEY: Thank you.
BY MR. MOTLEY:

Q Same numbering system, the same signature, the same logo, right?
A Yes.
Q Both of them say, Confidential?
A Yes.
Q Both of them have got the same court order stamp?
A Yes.
Q Okay. Now, Mr. Crist asked you about the document that you said was a nicotine substitute document; do you recall that? This one.
A Yes.
Q They did more than ask about nicotine in this document, didn't they, Doctor?
A Yes.
Q In fact, they asked these people if cigarette smoking in moderation is safe; do you see that?
A Yes. I haven't found it in the hard copy yet.
Q Well, just look on the TV to save time.
A Yes.
Q And the question is that cigarette smoking in moderation is safe, true or false; 41 thought it was true, 29 thought it was false, and 30 didn't know,

correct?
A That's correct.
Q Tar in the smoke is what is harmful to your health. 54 said that's true, 10 said it wasn't, 36 said they didn't know, right?
A That's correct.
Q Gas in the smoke is what is harmful to your health. 12 said it was, 24 said that's false, and 64 didn't know, did they?
A That's correct.
Q Smokers actually live longer than people who don't smoke at all. 3 said that that's true, 52 said it was false, and 45 said they didn't know.
A That's correct.
Q Does that indicate that they knew everything they needed to know about cigarettes, Doctor?
A No.
MR. CRIST: Objection, Your Honor.
THE COURT: Sustained. Anything else of this witness?
MR. CRIST: No, Your Honor.
THE COURT: You may step down.
THE COURT: Do you have a 12 minute matter to take care of? Wait a minute, hold on, before he goes away.

MR. MOTLEY: Can I confer a second, Judge?
THE COURT: Yes.
MR. MOTLEY: Your Honor, what I suggest we do so as to not take up the jury's time is to do this at the end of the day. We can do this after you excuse the jury. And he's not leaving until the morning, so if he doesn't mind waiting around.

THE COURT: Do you have something short?
MR. MOTLEY: No, sir, nothing short.
THE COURT: Let's take a break now. It's 20 after by that clock. The recess will be until 3:35 by that clock.
(Brief recess.)
(The following proceedings were held in open court, outside the presence of the jury:)
MR. WILNER: Our next witness will be by deposition, and we would ask the court -- request that the deposition introductory instruction be given.
MR. MOTLEY: I was going to tell the jury --
THE COURT: Pardon me?
MR. MOTLEY: I was just going to tell them where it was taken and when because it's not on the tape because we edited a bunch of stuff out

to save time. If counsel will permit, I'll just say who he is and where it was taken. I don't know what Mr. Wilner wanted to add after that. Just that it was taken in January -- there's two different back drops.
THE COURT: Any objection to that?
MR. CRIST: Not in principle, as long as long as there's not a lot of flourish.
MR. MOTLEY: I had a drum roller in the back.
THE COURT: Any music?
MR. MOTLEY: Dr. Pollay has agreed to sing the national anthem of the United Kingdom.
THE COURT: I've heard it's Oh, Canada.
MR. MOTLEY: He does that one too.
THE COURT: Okay. This is Sir --
MR. MOTLEY: Sir Richard Doll.
THE COURT: Sir Richard Doll, D-o-l-l.
Recall the jury. How long is this?
MR. MOTLEY: One hour and 27 minutes.
(The following proceedings were had in open court, in the presence of the jury:)
THE COURT: Members of the jury, the sworn testimony of Sir Richard Doll given before trial will now be played to you on videotape. You are

to consider and weigh this testimony as though the witness had testified here in person.
MR. MOTLEY: Ladies and gentlemen, this deposition was taken on January 17th and January 20th, but there's a part of it --
THE COURT: What year.
MR. MOTLEY: 1997. In Florida. But there's a few additions in the back that has a different back drop. It was taken on January 15th, but just in a different location, but it's the same series of deposition questions and the same lawyers.
THE COURT: Thank you.
(The videotape was played as follows:)
BY MR. MOTLEY:
Q Good morning. Would you please state your name for the record?

A Richard Doll.
Q My name is Ron Motley, and I represent the state of Florida and the state of Texas. Good morning to you, sir.
A Good morning.
MR. MOTLEY: Your Honor, would you like for the attorneys --
THE COURT: Stop. Stop the tape for just a second.
(The videotape was stopped.)
THE COURT: Are you filming the jury?
UNIDENTIFIED SPEAKER: No, sir. All I can see is the television monitor and that's it.
THE COURT: Okay.
(The videotape was played as follows:)
MR. GROSSMAN: I'm Mr. Grossman, I'm the lawyer on behalf of R. J. Reynolds Tobacco Company.
THE JUDGE: Mr. Grossman, you will be conducting cross examination.
MR. GROSSMAN: Yes, I will.
BY MR. MOTLEY:
Q Good morning again, Dr. Doll. Where do you live, sir?
A I live in [DELETED].
Q And how old a gentleman are you, sir?
A I'm 84.
Q And you are married?
A Yes, I am, happily.
Q Happily married. And I know you say that -- Lady Doll, I believe, is here with us today.
Do you have children, sir.
A Yes.
Q How many do you have?
A We have three.
Q What is your profession, sir?
A I am a medical physician who has specialized in epidemiology for the last 45 years.
Q 45 years?
A 50 years.
Q 50 years. Sir, you have the name, in addition to Dr. Richard Doll, Sir Richard Doll. Can you tell us how you became to be called Sir Richard Doll?
A Well, this is a title that is awarded in England technically by Her Majesty, but in fact by the government. And such titles -- a number are awarded every year for service to the country of one source or another.
Q When did you receive this you ward, sir?
A I forget exactly. 1967, was it? I think somewhere around there.
Q And what was the basis for your receiving this award, sir?
A The research work I had done which had -- the results of which it was hoped would lead to improvement in public health.
Q Dr. Doll, among your many honors over your

career, did you receive the Companion of Honor award in 1996?
A Yes, I did.
Q What is that, sir?
A That is a very high honor in England. It's only given to 60 people -- 65 people altogether, and I was delighted to get it. It's given to people in all walks of life: politics, art, science; and I was fortunate to be awarded it last year.
Q Sir, have you been appointed to membership and, indeed, become the director of the Medical Research Council of Great Britain?
A I have been employed by the Medical Research Council for a number of years, and then when I went to Oxford University, I became a member of Medical Research Council for some years.
Q What is the Medical Research Council?
A Medical Research Council is a body that is -- receives government money to do medical research which it organizes and is responsible for. So it has government money, but it doesn't carry out research as instructed by the government; it's own council determines what research it shall support. And the Department of Health has other money which does government-sponsored research. The Medical Research

Council is an arm's length from the government.
Q Sir, have you received the United Nations award for cancer research?
A Yes, I have.
Q Have you received the presidential award of the New York Academy of Sciences?
A Yes, I have.
Q The Gold Medal from the British Medical Association?
A Yes.
Q And the Royal Medal from the Royal Society in Great Britain?
A Yes.
Q Dr. Doll, how many scientific articles have you authored?
A The last number in my bibliography is about 436, I think.
Q Scientific articles?
A Yes.
Q Sir, can you tell us how many of those have dealt with cancer research, approximately?
A That's very difficult. Perhaps half.
Q How many of your articles, if you can approximate for the jury and the Court, of your articles have dealt with lung disease?

A Well, this is guesswork. Perhaps getting over a hundred, I dare say.
Q Dr. Doll when did you first develop an interest in studying diseases caused by cigarette smoking?
A In 1947 when I was invited by Professor Bradford Hill to work with him the following year. I hadn't had any interest in it until then, but

naturally when he asked me to work with him to try to find out the causes for the increase in lung cancer which had occurred in Great Britain, I began trying to think of all of the possible things that might have been responsible for that increase; and cigarette smoking was, of course, one of the factors which was included.

Q Dr. Doll, when did you actually begin studying cigarette smoking in connection with lung cancer?

A First of January 1948.

Q Almost 50 years ago?

A Yes.

Q Would you describe for the ladies and gentlemen of the jury and the Court how you began your investigation, that is, what did you do?

A We arranged to interview patients with lung

cancer and ask them questions about their past experiences. Of course, the way we designed our study, which included making inquiries of patients with two other types of cancer, cancer of the stomach and cancer of the large bowel, and also a large number of control patients with other diseases. We also asked questions which might not have appeared to be a direct concern to patients with cancer of the lung, such as aspects as of their diets and the use of fried foods.

We also asked them about all of the illnesses they'd had, especially respiratory illnesses. We asked where they lived. We asked all of the occupations that people had had, occupations that they had had for more of one year in the industries in which they worked. We asked about their family history.

Q Is there a descriptive term that scientists use to describe the type of study that you began in 1948?

A Yes, we call that a case control study in which you ask -- try to find out about the experience of -- past experiences of people with the disease you're interested in and people who haven't got that disease.

Q All right, sir. Sir Richard, could you tell the jury and the Court what your study, the first one in 1950, on cigarette smoking and lung cancer revealed?

A It revealed a very close association between individual's smoking habits and the disease of lung cancer. We examined the results in detail relating -- for example, relating us only to the amount that people smoked, the age at which they started smoking, the age which they stopped smoking, if they had stopped smoking, the type of smoking material they used.

And we calculated, from comparison of the lung cancer patients and the control patients -- after having very rigidly defined a nonsmoker as somebody who had never smoked for as long as -- as much as one cigarette a day for as long as one year -- we found

that heavy smokers had about -- we estimated about 25 times the risk of developing lung cancer as lifelong nonsmokers.

We then considered these findings the light of a lot of other information. We tried to think whether these findings could be due to bias in the way the data had been collected or the way patients had been selected for the controls. We came to the

conclusion that bias couldn't explain it, particularly because we found that the results were quite different in patients who were proved to have lung cancer after discharge from the hospital. And patients who had been interviewed on the belief that they had had lung cancer but who turned out to have some other disease, they had the same smoking habits as our controls. We decided that bias couldn't explain the results.

We thought about confounding. Now, by "confounding" we mean a situation in which there is a common cause both of the disease that a person has and of the factor that's been associated with the disease; in this case, smoking. To give an example of what we mean by confounding, one finds that cigarette smokers, heavy cigarette smokers in particular, are more likely to be consumers of alcohol than nonsmokers. So that when you find a relationship between cigarette smoking and cirrhosis of the liver, this turns out -- can well be explained by the fact that alcohol causes cirrhosis of the liver and cigarette smoking appears to be associated -- is associated with it just because cigarette smoking is associated with heavy consumption of alcohol.

So we had to try and think if there were any common factors that could have caused both the patient

to smoke and the development of the disease, and we thought of all of the things at the time that seemed at all plausible, the socioeconomic status of the patient, the area where they lived.

At that time we were interested in proximity to gasworks, which we thought might produce carcinogenic substances, but none of the things that we could think of that could account for confounding -- could result in confounding and actually explain the results. And we concluded, therefore, that -- we then had to consider whether it would make sense that the cigarette smoking was a cause of the disease.

We looked around at all of the other evidence available in the world. We said, Well, if cigarette smoking is a cause of the disease, it should be more common in men than in woman, because more men smoke more than woman, and of course it was. And then we thought, Well, how does this apply to other countries? Can we think of any countries where cigarette smoking is uncommon? And let's see if lung cancer occurs there at all commonly.

We found there were countries where cigarette smoking was uncommon, Iceland in particular, Norway to a considerable extent, and we found that lung cancer was much less common, indeed, extremely

rare -- rare in Iceland.
So having decided that we couldn't explain the results by bias or by confounding, and having found that the idea that cigarette smoking was a cause made biological sense, we -- made biological sense not only from the sort of data we had, namely if the greater risk was earlier age of starting, the reduced risk was age of stopping and that sort of thing, but also made sense with ecological data about the distribution of lung cancer and cigarette smoking by sex and throughout the world, we concluded that smoking was a cause of the disease, or was a principal cause of it, and we said so in that paper.
I think -- to my mind, that is the thing with, looking back, I am most pleased with, that we did have the confidence to decide that on the basis of the data that we'd been able to collect and knowledge that was available worldwide, we were able to conclude that smoking was an important factor in the production of carcinoma of the lung.
Q Did you reach a conclusion that there was a causal relationship between cigarette smoking -- heavy cigarette smoking and lung cancer?
A No. We reached a conclusion that there was a relation between cigarette smoking and lung cancer,

and it didn't seem to be -- require heavy cigarette smoking. It was proportional -- the risk was proportional to the amount smoked down to quite small amounts.
Q Did the risk increase with increasing the numbers of cigarettes smoked, Sir Richard?
A Yes, it did. And this, of course, was one of the bits biological evidence. When I said it made biological sense, we found that the risk increased with the amount smoked.
Q Can you confirm for the jury and the Court whether this is a xeroxed copy of the original article published in 1950 on cigarette smoking and lung cancer?
A Yes, it is.
Q Smoking and carcinoma of the lung by Richard Doll and Bradford Hill. Would you just take a moment, sir, and tell the jury and the Court who Bradford Hill was?
A Bradford Hill was the professor of medical statistics at the London School of Hygiene and Tropical Medicine, and had been so for some five years, I think, when I went to work with him. But he has been, I think, fairly widely accepted as probably the most important medical statistician of the first

50 years in the English-speaking world, not because of any brilliant discoveries in theoretical statistics, but because of his ability to explain simple statistics to a medical profession, which was essentially enumerate and quite unaccustomed to using statistical calculations in his work. And he had a great capacity for explaining the simple things about statistics.

He also introduced the concept of randomized control trial, which is now universally considered the essential tool for discovering the way -- the usage of new drugs and new medical treatments.

Q Dr. Doll, I'm now going to show the jury and the Court a finding in your paper of 1950 from page 747, and I'm going to read it to you. In your paper, you and Mr. Hill conclude that, Reasons are given for excluding all these possibilities, and it is concluded that smoking is an important factor in the cause of carcinoma of the lung. Do you recall making that finding, sir?

A Yes.

Q Doctor, how long have you studied -- how long have you been involved in the studying of the effects of cigarette smoking on human health?

A How long had I been --

Q How long had you -- is this the only paper you wrote on cigarette smoking and disease, or have you studied it throughout your career?

A Since then, I frankly got rather bored with the subject, but I haven't been able to get away with it, and I have been writing papers on it for the last 50 years. The last one I wrote was in 1994 with my younger colleague Professor Peto.

Q Dr. Doll, when did you next undertake a study of cigarette smoking and its effect on human health?

A Well, we went straight on from 1950 to start -- well, to do two things. Firstly, we wanted to show that the findings that we had obtained for patients in London were, in fact, characteristic of the whole country, and so we extended our case control study to include patients in four others towns and to double the number of patients we had altogether in our studies. And we published this in 195- -- the results in 1952. They were essentially the same on -- now on about 1500 patients with lung cancer and a similar number of controls.

But because we had found a lot of people were skeptical of our conclusion that smoking was a cause of lung cancer, we thought we ought to try and

investigate it by some other means. Bradford Hill thought, and I agreed with him, that any responsible scientist, if they make what seems to them a discovery that is of some potential importance, you should then try to disprove your conclusion if you possibly can, just to check that it's right.

We thought that the British medical profession might be a good group of people to study for three reasons. We thought that they might perhaps give out -- be more interested in answering questions than other people. Secondly, we hoped that as trained scientist, they would be more accurate in their reports. But most importantly, we thought they'd be easy to keep an eye on, because for legal reasons, their names have to be kept on registers.

And within two-and-a-half years, we found that our prediction, in fact, was correct, that even

with only 36 deaths from lung cancer, the relationship between these were nearly -- mostly occurred in heavy smokers. And the relationship between smoking and the risk of lung cancer in this so-called prospective study -- we now call it cohort study -- in which you follow forward people whose exposures you already know, they gave almost identical results with those that we had obtained in our case control study, and we

published those results in 1954.

Q How many doctors were enrolled in your study and followed over time?

A 40,000. There were 34,000 male doctors and 6,000 female doctors.

Q Dr. Doll, who was the first scientific investigator in the world to prove that cigarette smoking caused lung cancer?

A Well, Bradford and I were the first people to say that we thought we had proved it, so rather -- the first people in the English literature.

Q Dr. Doll, did you continue your study of British physicians in the mid 1950s? You've told us you published the original article in 1954. Did you subsequently, in the 1950s, publish additional information about the British physicians that you were following?

A Yes. We published in 1954 because we thought we should publish it as soon as we had sufficient evidence to confirm the validity of our case control study, but the numbers were small and, of course, we were not able to look at many other diseases.

But in 1956 the numbers were really quite substantial. We had over 80 lung cancer deaths, and

we published it again. And we then looked at other diseases, and we were struck by a relationship between smoking and chronic thrombosis or myocardial infarction.

Q Heart --

A Heart attacks.

Q Yes.

A And we suggested that smoking might be a contributory factor in the production of that disease as well.

P R O C E E D I N G S
April 22, 1997 4:00 p.m.
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(The following proceedings were reported by Deborah Pacetti:)

Q Dr. Doll, while you were publishing your studies in the early mid 1950s in Great Britain, were any American scientists publishing similar findings?

A Yes. The American Cancer Society carried our a very similar study to our study of doctors but with numbers but. It was 200,000 Americans. This was done by Dr. Hammond and Dr. Horn. Simon Hammond, who worked for the American Cancer Society became a close friend of mine and he told me at a meeting that we both attended in 1952 that he was carrying out the study but he was convinced that smoking was not a cause of lung cancer but he wanted to prove that what it wasn't. Of course, by 1954 they had results that were almost identical with ours and he published -- he and Horn published a paper in which they concluded that smoking was not only a cause of cancer of the lung, but was also a cause of chronic thrombosis.

Q Have you studied over time the effect of people -- on people's health if they do stop smoking and remain stopped?

A Yes, indeed we have. That has been one of the most central points in some of our later papers because it was obviously important to know whether there was any benefit from stopping smoking. And in a 1976 paper we paid -- after following doctors for 20 years, we paid a lot of attention to that, and even more attention in our 1994 paper, but, of course, we say we've been following doctors for 40 years, we didn't just have their smoking habits in 1951 when they -- when they first completed our questionnaire, we had written back to them every five to ten years and in between -- I think there was a gap of 12 years on one occasion -- and we had information about their changes in smoking habits.

Of course, we found the effect on giving up was different for different diseases. For lung cancer, the risk was never returned to normal, what happened was stopping smoking was that the risks stopped getting any greater, so that within ten years, the risk was less than half what it would have been if people had continued smoke; whereas, with chronic thrombosis or myocardial infarction, there was a much quicker effect, and the effect returned almost to that of a life-long non-smoker which the -- with lung cancer was never quite the case.

Chronic bronchitis and emphysema on the other hand, although stopping smoking prevented it from getting any worse, but the damage had been done, and it was quite impossible to undue that damage, and a lot of peoples with that disease still died of the disease even the if they gave up smoking.

Q From 1950 to 1990, sir, would you say you've followed the world literature on cigarette smoking and lung cancer?

A Yes.

Q Did you follow it closely?
A Yes.
Q Dr. Doll, can you tell me, sir, whether you have encountered an epidemiological study from 1950 to 1990 in which it was concluded that cigarette smoking was not a risk factor or cause of lung cancer in smokers?
A No, I haven't.
Q Dr. Doll, can you give the court and jury your professional opinion based on your own research and your studying of the research of other scientists as to when the medical and scientific community reached a consensus that cigarette smoking was a cause of lung cancer in smokers?
A In England, it was accepted by all serious

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scientists, to my knowledge, that cigarette smoking was a cause of lung cancer in about 1957, following a statement published in the British Medical Journal by the Medical Research Council which had been made as the result of a request of government to advise them on whether smoking was a cause of lung cancer, and in this article in the British Medical Journal the Medical Research Council said it should be concluded that smoking had been responsible for the greater part of the increase in the mortality from lung cancer.
I don't recall the question being seriously -- the conclusion being seriously questioned after that by people that I met in epidemiology or in cancer research.
Q Dr. Doll, would you give the court and the jury your opinion as to what percentage of lung cancers that occur in human beings are caused by cigarette smoking?
A Well, this varies, of course, from year to year depending upon the amount of -- the amount of lung cancer that's occurring. At the height of the epidemic in England, and we're now well past the height of the epidemic, I'm glad to say the disease is becoming less common every year, but at the height of the epidemic in men, I estimated at 95 percent of lung

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cancers were caused by smoking in the sense that had the individuals not smoked, 95 percent of those cancers would not have occurred.
The proportion in women has been smaller and is still going up because women didn't start smoking early in life and continue smoking for a long time, for many years after men did that, and the proportion in women has not gone above 90 percent.
Q Doctor, have you reached an opinion based upon reasonable medical probability or certainty as to what diseases in addition to lung cancer are caused by cigarette smoking?
A Yes.
Q Could you tell them to us, please, sir?
A Something to the order of some 30 diseases are reasonable to the -- to the extent of reasonable medical proof are caused by cigarette smoking. It's a little artificial to distinguish some of these diseases because a lot of them have the common background of vascular thrombosis, that's to say clotting in the arteries, but we -- they're given

different medical titles so we call them different medical diseases. I'm thinking for example of chronic thrombosis and cerebral thrombosis, two forms of thrombosis, but they're different diseases, they

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between different clinically, and they are both in part caused by cigarette smoking.

There are about ten types of cancer that are caused by cigarette smoking. Eight of these have been accepted as caused by cigarette smoking by the International Agency for Research on Cancer at a meeting in 1986, since then there has been added information on some of the rarer types of cancer which allows me to conclude that several other types of cancer are also caused by smoking.

But so many are caused by smoking, it's not surprising because cigarette smoke contains so many different carcinogens, at least 50 are recognized as causing cancer in animals and several of them are known to cause cancer in humans. For example, there's a chemical called tulathylamene [phonetic] which in the chemical industry is proved to be a very powerful cause of bladder cancer in humans. This is present in cigarette smoke and it's perhaps therefore not surprising that smoking causes quite substantial increase in the risk of cancer of the bladder.

Similarly, there are smaller amounts of benzene in cigarette smoke, and it's not surprising that there is a very small increase of myeloid leukemia in cigarette smokers. But the common

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cancers, which are -- a large proportion of which are caused by smoking in the sense that in the absence of smoking, they would not have occurred, are cancer of the mouth, cancer of the pharynx, the larynx, the esophagus. Those are the ones very closely related. Then there is cancer of the bladder and cancer of the pancreas, which have a substantial proportion, over 50 percent in Britain have been caused by smoking. And then there are other cancers which smoking contributes to only a very small part, such as cancer of the stomach, myloid leukemia, cancer of the nose, and that's a very rare cancer so it's taken a long time to collect data on that.

There are a lot of vascular diseases, diseases of the blood vessels. The best well-known is myocardial infarction. We tend nowadays to talk about ischemic heart disease. That a whole category of disease in which -- of the heart in which it's damaged by clotting of the arteries that feeds the muscles of the heart. Myocardial infarction, cerebral thrombosis, but a much a much higher -- much higher proportion of the conditions are caused by smoking for some rarer types of vascular disease. Particularly an aortic aneurysm, that's about 5 or 6 times as common in cigarette smokers as to non-smokers, an anoxic

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condition of the big blood vessels that carries the blood from the heart down to the -- down to the lower limbs, and when the vessel gets weekend, it bulges and eventually bursts, that what we call a ruptured aortic aneurysm. That's quite an important cause of death now. That is very closely related to smoking.

Then there's peripheral vascular disease, types of vascular disease of the arteries leading to the limbs which may lead particularly to gangrene of the toes. Gangrene closure of blood supply to the extremities might eventually lead to loss of the limb.

There's an extreme form for that disease called Buerger's disease which was discovered by a German in 1908 and described by him then as being caused by smoking. In fact, there is quite convincing evidence in retrospect in 1930 produced by an American called Silbutt [phonetic], that Buerger's disease, which is rare disease, is nearly always caused by smoking. Very, very high percentage, well over 90 percent, if not 95 percent of cases.

Then there are respiratory diseases, the most important being what we call chronic bronchitis and what is commonly called chronic bronchitis and emphysema, or technically now we give it another name, we call it chronic obstructive pulmonary disease, or

in England, chronic obstructive lung disease. This is a very unpleasant disease in which the respiratory efficiency of the lungs gradually diminishes until a person is unable to even walk across this room without him being short of breath.

It's a disease which is some 20 times -- the deaths from this disease is some 20 times as high in cigarette smokers as in life-long non-smokers. Again, as with many of the diseases to which cigarette smoking contributes as a cause, it is caused by other things which interact with cigarette smoking, but everywhere it's found that this disease in absence of cigarette smoking is really quite rare.

There are a number of other diseases, I think I might have to refresh my memory by looking at the lists, but . . .

Q May I hand you this? What is the next number, ma'am?

A We should have had hypertension and arterial disease, arteriosclerosis in general. Then there's pulmonary tuberculosis itself. Of course, smoking doesn't cause pulmonary tuberculosis, but there have been umpteen papers written saying that it does occur more commonly know than in non-smokers, but what smoking does is it makes it much more fatal.

Nowadays fortunately with the treatments we have you don't see in very often, but before we had the effective treatments for pulmonary tuberculosis. Smoking increases the mortality of that. Asthma is a disease which is made worse by smoking, so much that most asthmatics give up smoking.

Peptic ulcer, gastric duodenal ulcer, and it's diseases which I have personally worked on intensively. Then there are some rare diseases like Crohn's disease of the small -- of the large bowel -- I'm sorry, of the small bowel, but it's principally the small valve. There are some very rare diseases, like one type of blindness called tobacco amblyopia, and it's recently been shown that quite a confluence of blindness in old age, macular degeneration in old age is probably caused by smoking in the sense that it is several times more common in continuing cigarette

smokers than in non-smokers.
I think I have mentioned most of the diseases in which -- and I recognize to be caused by smoking, but there are a few more.
Q Dr. Doll, I have been asking you some questions and one of my colleagues pointed out I failed to get to you give the jury and the court your definition of epidemiology. Since a lot of the work

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you have done is in the form of epidemiological studies, would you kindly explain to the jury just generally what epidemiology is?
A Yes. Epidemiology is the study of the distribution of disease in human populations relating the frequency with which the occurs to the characteristics of the groups of populations in whom the disease occurs with a view to finding out what are the causes of disease. It's also been extended to cover the treatment of disease with different forms of treatment, but basically it's a study of the variation and the distribution of disease in different groups of people to find out what are the characteristics that contribute to the development of the disease they get.
Q Doctor, could you give us your opinion as to what percentage of long-term heavy cigarette smokers, let's say smoke for 30 years a pack and a half a day, what percentage of such people will develop, in your opinion, a cigarette-caused disease of any kind?
A Oh, well over 50 percent, 70 or 80 percent. 50 percent of continuing cigarette smokers in studies that I have carried out have actually died of a disease from which cigarette smoking has been the principal cause of.

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Q Doctor, would you define for the court and jury what you mean as a scientist when you use the word "synergistic"?
A Yes. I mean by that two things are acting increase the effect of each other. Now, we have very a good example in asbestos and cigarette smoking in the cause of lung cancer. A non-smoker heavily exposed to asbestos only has about five times the risk of developing lung cancer that a non-smoker is not heavily exposed to asbestos has.
The cigarette smoker, that average cigarette smoker not exposed -- not heavily exposed to asbestos will have 20 times the risk of developing lung cancer than a non-smoker has. Now, what happens when a cigarette smokers is also heavily exposed to asbestos? You don't get a risk which is the sum of the two risks, you don't have 20 plus 5 causing a 25 fold increased risk, you have a 20 times 5 fold increased risk. You have nearly 100 fold increased risk in the heavy -- in the average cigarette smoker heavily composed to asbestos.
Asbestos and smoking are acting synergistically to increased each other's effect if they had been experienced just by themselves.
Q Doctor, is there a synergistic relation, in

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your opinion, between cigarette smoking and a human being's diet?

A Yes, I think there is. It's well-proven in the example I've given you that I think most scientists who studied it would agree that there was.
Q Same question the cigarette smoking an air pollution?
A That is -- the evidence is weaker, but most again scientists that have been especially interested in this agrees that the two do act synergistically.
Q Is it -- in your opinion as a scientist, a fair comparison to compare bowls of cherries, cooked carrots or charcoaled steaks with the diseases that you have described are caused by cigarette smoking?
A Well, as causal factors they are trivial or nonexistent to comparison of cigarette smoking.
Q Trivial or what?
A Nonexistent.
Q Thank you, sir. Dr. Doll, has science identified known carcinogens, that is things that cause cancer in cigarette smoke?
A I missed the first part of the question.
Q Has science --
A Has science.
Q -- science identified known cancer causing

substances in cigarette smoke?
A Science has identified some 50 known chemicals that are carcinogenic to animals in animal experiments.
Q Doctor, let me ask you this question, sir: If you would assume for me that an individual has smoked one and a half packs of filtered cigarettes for 30 years and contracts lung cancer, can you tell the court and jury based upon reasonable scientific probability whether or not the cigarette smoking that I have described is a cause, a substantial contributing factor cause in the lung cancer of this individual?
A Beyond all reasonable doubt it is -- it would have been -- it would be a substantial contributing cause.
Q Dr. Doll, if -- were you ever asked from 1950 up until this very day by any tobacco company in the United States or Britain to design a policy to advise people who smoke cigarettes of the dangers, have you been so consulted?
A No.
Q I would ask you hypothetically, sir, had you been consulted in 1955 to advise cigarette companies in the United States and in Great Britain to design a

policy of information to impart to consumers of cigarettes, what would you have told them, sir?
A I would have told them that the smoking of cigarettes was a sub- -- would actually have a substantial -- would produce a substantial risk of developing lung cancer and quite probably several other important diseases, and that the pubic should know that.

EXAMINATION

BY MR. GROSSMAN:
Q You have never undertaken an independent study of the internal corporate documents of any American tobacco company; isn't that correct?

A That is correct.
Q You have never worked in a private company at all; is that correct?
A That is correct.
Q You're not an expert in corporate ethics; is that correct?
A That is correct.
Q You -- you have said that you were not an expert in the review of internal corporate documents; isn't that correct?
A That is correct.
Q You have never reviewed the files of any

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American tobacco company; is that correct?
A By reviewed you mean examined?
Q Yes.
A No, I haven't.
Q Now, in order to determine what chemicals might be responsible for disease, the first thing that's necessary or has been necessary is to determine what chemicals are in cigarette smoke; is that correct?
A That's been very desirable to determine that.
Q It's the obvious logical first place to again; isn't that correct?
A Yes.
Q Now, in the 1950s, how many chemicals in cigarette smoke were known in the early 1950s?
A In the early 1950 very few.
Q Today there are about 4,000 chemicals known; is that correct?
A I believe.
Q That's a tremendous contribution to the literature, isn't it?
A It's been an important use for contribution.
Q Do you know who made that contribution?
A Yes, I think I was told yesterday that the

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Tobacco Research Council in the United State -- no the research workers employed by the tobacco industry in both the United States have made that contribution.
Q Have made that contribution to the literature. And it was they who undertook the research to find out the chemical components of cigarette smoke?
A Not only them, of course there is Dr. Hofmann who worked for Wynder and his group who have made major contributions to the content of cigarette smoke. So it would be quite wrong to apply that it was only the tobacco companies that had made these contributions.
Q But certainly to the extent that the American tobacco companies have expanded the scientific knowledge by isolating and determining the chemical compositions, you would applaud that work, isn't that right?
A They have contributed to knowledge and I applaud that contribution.
Q Okay. Doctor, your testimony earlier -- I don't want to go back over it again -- was that given the large number of chemicals in cigarette smoke, the initiators, promoters and inhibitors, no one knows the

precise chemicals that account for the observed

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increase in lung cancer in humans; isn't that correct?
A That is correct.
Q Now, Doctor, in light of that, one way of reducing the potential risk of cigarettes was to reduce all of the chemicals, isn't that right?
A All of the chemicals that was all likely to cause cancer, yes.
Q All of the tar?
A And, of course, the promotors as well as the initiators to reduce the tar, yes.
Q And, in fact, over the last several decades there has been a tremendous reduction in tar in the cigarettes smoked in the United States; isn't that correct?
A Yes.
Q In early 1950s, the average cigarette in the United States had been 45 milligrams of tar; isn't that right?
A I think I said yes to that, I wasn't sure. I knew what it was in England.
Q But you know it was about that; isn't that correct?
A It was certainly well over 30, 35.
Q That was true both of filtered and unfiltered cigarettes; isn't that correct?

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A If it was true with filtered cigarettes, then at that time perhaps the filters weren't effective.
Q In the very beginning?
A In fact, they weren't as effective as the tobacco itself.
Q But today the tar has been reduced manifold, several fold; is that correct?
A Yes.
Q It is several times lower in content in the smoke than it was in the early 19 --
A Well, about a third, yes.
Q At the World College of Physicians, people from a tobacco company were there and you implore them to try to make low tar cigarettes, isn't that correct?
A I didn't employ --
Q Implore.
A No, I don't implore people doing. I advise them if they wanted to reduce the risk of lung cancer, it would be a good thing to do.
Q You have written and testified extensively in the past that lower tar cigarettes reduce the incidence of lung cancer in humans?
A I believe they do, yes.
Q Now, Doctor, you believe that the case is

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made, that is that it has been proven that lower tar cigarettes reduce the risk of lung cancer; isn't that correct?
A I think it's been proven beyond reasonable doubt that lower tar cigarettes do reduce the risk of lung cancer to some extent.
Q Now, starting in at least 1977 you suggested that cigarettes might be made less risky if in addiction to reducing the tar, one in enhanced the

nicotine; is that true?
A Yes, I did.
Q And you continued to take that position over a period of many years; was that correct?
A Yes.
Q And it would be responsive and appropriate for tobacco companies, hearing your statements and those of the surgeon general to undertake research to make lower tar to nicotine content ratio cigarettes; is that correct?
A Yes, sir.
Q You idea was actually to spike low tar cigarettes with nicotine; is that correct?
A I don't know that I've ever used the word "spike," but I think I -- what I was suggesting was that if you could reduce the tar without reducing the

nicotine, and I think I may have actually said some -- add some nicotine, but I don't particularly like the word "spike".
Q Maybe it was not the word "spike." Your idea was to add nicotine to the low tar cigarette?
A Yes.
Q And to the extent that American cigarette manufacturers experimented with that, you don't criticize the work, but applaud it; isn't that correct?
A I don't applaud, I think it's a sensible thing to try to do.
Q Now, Doctor, you believe that there is no harm in tobacco companies funding biomedical research providing scientists retained total control over the use of the funds and the rights to publish the research; isn't that correct?
A That's correct.
Q It's fair to say that when you started work in this field, most scientists were not convinced by your work that smoking was a cause of lung cancer or any others disease; isn't that correct?
A In 1950 for the first year or tow, that would be correct to say.
Q In fact, around 1950 most scientists were

used to looking at the idea of cause and effect from the perspective of Koch's postulates; is that right?
A That was what they had been taught in medical school, they stuck to that.
Q And Koch's postulates, which were taught in medical school as the grounding for determining cause and effect, positive that cause and effect could not be established unless an exposure where the necessary and sufficient cause of a disease; is that correct?
A Don't think it was always sufficient, but it certainly was necessary. I'm thinking for bacteria infections, for example, many people would be affected with a diphtheria bacillus but would not have diphtheria, but you couldn't have the disease diphtheria without being infected with diphtheria bacillus. So it was necessary but it wasn't sufficient.
Q Now, under Koch's -- getting back to the question of necessary and sufficient. It is correct, is it not, that cigarettes are neither a necessary nor

sufficient cause of lung cancer?
A That is true.
Q And it is correct, is it not, that cigarettes are neither necessary nor sufficient cause of emphysema or chronic bronchitis?

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A That is true.
Q Now, one other thing that was concentrated on by many scientists that period was what is referred to as mechanism; is that correct?
A And indeed still is.
Q Indeed still is. And it is fair to say, isn't it, that the mechanism for cancer of any type has not been fully described?
A Not fully described, but, of course, we understand a lot about the mechanism by which cancer the produced now.
Q There have been developments in the understanding of mechanism over the past few decades?
A There have indeed.
Q And research into mechanism has been, you have viewed, very important?
A Yes.
Q Now --
A Not as important as the research into the epidemiology of the disease, but that's a matter -- I think people would differ over that.
Q Reasonable people would differ on that?
A I think there would be reasonable difference of opinions over that.
Q But even today, the mechanism of lung cancer

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has not been fully described?
A Not fully, but you we know a great deal about it.
Q In your first study, in the case control study, and perhaps we can define the terms here.
A Yes.
Q A case control study is taken retrospectively; is that right?
A Retrospectively in the sense that you are obtaining information about the individual's exposure after his disease is developed.
Q Now, your British physician's study was not randomly drawn; is that correct?
A No.
Q That is correct?
A It was not a random population.
Q It was not representative of the British population as a whole?
A No.
Q Correct?
A Correct.
Q Now, the American Cancer Society's call CPS-1 and CPS-2 similarly are not randomly drawn; is that correct?
A That is correct.

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Q They were composed of members of the American Cancer Society and their friends and family; is that?
A Right. The only randomly drawn I know of is the Swedish one.

Q Again, you found that overall people who shade they inhaled had a lower rate of lung cancer than people who said they did not?
A Yes, that continued to be true.
Q And you published that it was your view that overall deep inhaling of cigarette smoke was protective of lung cancer; is that correct?
A That was what our data showed, and which made search in light of the respiratory physiological information that we had from specialists in respiratory physiology.
Q Now, Doctor, there are a number of -- it's very important in attempting to interpret the results of a survey to ensure that the apparent association is not explained by confounding; is that correct?
A That is right, yes.
Q Now, one must also religiously try to avoid bias; is that correct?
A Not religiously because that night be emotional. One must make strict -- know every effort

one can to avoid bias.
Q Bias, there may be several forms of bias?
A There may.
Q One kind of bias has been referred to as the wish bias?
A Yes.
Q What is the wish bias?
A The wish bias is the wish on the part of the patient to attribute his condition to something -- take something to which he has been exposed, usually something that somebody else has exposed him to, that would be an example of the wish bias.
Q Another type of bias is called observer bias.
A Yes, indeed.
Q What is that?
A Observer bias is bias in the recording of the information provided by the subjects of your study, because the observers, sometimes conscious or often unconscious desire to obtain a particular result. And so for example in relation to cigarette smoking, the observer, if they thought that cigarette smoking was a cause of the disease they were investigating, they might press a non-smoker much heard saying, "Are you quite sure you've never smoked

as much as that, whereas if a control said they were a non-smoker, they might write that down straight and not go any further.
Q Now, you said earlier that give you artifact as a form of bias?
A Yes, yes.
Q Could you explain what artifact is?
A Well, you may have artifact in, for example, the increase of lung cancer in all developed countries occurred during the early decades of this century at the time when the methods of diagnosis were greatly improving. So you could -- it was thought for a long time that the increase in lung cancer was an artifact of improved methods of diagnosis, correct diagnosis instead of previously having misclassified lung cancer, for example, as tuberculosis which had been a

common condition.
Q And you yourself believe that in the period -- in the first half of this century, much of the observed increase in diagnosis of lung cancer was artifact; is that correct?
A Much the increase in the attributable deaths and attributing deaths to lung cancer was an artifact due to better diagnosis and greater appreciation of the condition of lung cancer.

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Q And that's because the methods of diagnosing lung cancer only developed the first half of the century to a large extent?
A That's right, yes.
Q Those were x-rays and --
A Pretty a bronchoscope down.
Q Bronchoscope, chest surgery --
A Yes.
Q -- like all the rest?
A Yes. Very for treatment of pneumonia, which by treating a pneumonia would allow an early cancer that had actually knocked the tube and caused the pneumonia to develop, whereas without the treatments that we now have, the man would have died of pneumonia and never had his lung cancer recognized.
Q You are familiar with numerous studies on autopsy surprise?
A Yes, I have. Yes.
Q And they may be of many types, some serious and some minor; is that right?
A That's correct.
Q But studies conducted in the United States and England have shown with regularity that a substantial number of cancers have a misdiagnosed primary site determine only on autopsy; is that

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correct?
A A proportion, not a very high proportion. The Hammond and Horn study in 1958, I think -- now I forget the portion I'm trying to recite, something of cancer, I'm sorry. Yes, the primary site has been found to be wrong in a number of cases, yes.
Q Now, Doctor, another type of bias that it's important to root out is called selection bias; is that correct?
A Yes.
Q What is selection bias?
A Well, selection bias can be of all sorts. One is -- let's say in selecting your control group -- let me make a criticism of a technique that is used very often now which people may have heard of called random digit dialing. You want to get a hold of a random section -- random sample of the population of a town so you just dial telephone numbers at random and then you try to interview the people that reply. Well, a lot of people won't respond to such inquiries, and there is serious doubt about the validity of using people that respond to telephone inquires that have been initiated in this way as a control population. This is a form of selection bias.
Q I see, Doctor. You have said that there are

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in a sense two different types of selection bias, one

of which results spontaneously and the other which results because the researcher or others had an interest in the matter; is that correct?

A I'm not sure what you mean by spontaneous. I may have said it, but I . . .

Q Well, one kind of selection bias arises when -- for reasons that are not understood by the researchers, they select as a population a group that is unrepresentative of the whole?

A Well, if they do that, they should know they are doing it.

Q If I understand your testimony as you've given in the past, there are two kinds of selection bias. One that arises one might be viewed as the anterior motives of those who do the selection, and another which arises spontaneously?

A I was referring to a very unusual form of selection bias in that first lot. That was a -- as one meets sometimes the occupational studies when you are relying on information provided by some group of employers and they might -- well, this fortunately doesn't often happen, but you have to guard against the possibility that they suppress information about individuals with a particular disease, where you had

that possibility -- we had to have that possibility in mind, for example, when we did a study to see what the health of the participants in the nuclear bomb test in the Pacific was. It was the Ministry of Defense providing us what all the information about all the patients or were they perhaps suppressing information about some who had developed diseases that might be attributing to that exposure. That would be a form of selection bias. But fortunately, that's uncommon.

Much the more dangerous -- much the usual form is just not getting a standard response -- it's not getting a response from a representative sample by some people not bothering to respond or consciously not responding.

Q Now, Doctor, you as a scientists would much prefer to have all of the data rather than data selected by someone who has an interest in the outcome?

A Yes, indeed.

Q That is one form of selection bias that you have said you must religiously avoid; is that correct?

A I certainly said one would strenuously try to avoid it.

Q And if one were to add up all the causes, as you use the term, of any multifactorial disease, any

cancer or any heart disease, any other of the non-infectious diseases that you were referring to, the total causes could equal well over 100 percent?

A This is not a question of as I use the term, it's a question of as medical scientists use the term and general.

Q As the surgeon general uses the term?

A As the surgeon general uses the term.

Q And when the surgeon general says that in his estimation, 435,000 or so people die as a result of cigarette smoking, if one were to do the same analysis with regard to alcohol consumption and

dietary factors and the rest, it would add up to far more deaths than there are in the United States?
A Yes, it would.
Q All right. Now, let's turn for a moment to lung cancer. There are -- you have testified that the most important cause of lung cancer, in your opinion, is smoking?
A Not in my opinion. I've testified that it is the most important factor.
Q But in addition to smoking, there are a number of causes and factors that have been effected that have been mentioned in the literature?
A Oh, I could mention -- I could mention and

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be confident about certainly half a dozen, if not more.
Q Well, one is diet; is that correct?
A That is controversial, but I personally believe that diet does play a part.
Q In any event, Allabania and the others working with him found and published in the Journal of the National Cancer Institute that there was a strong statistical correlation between women's -- nonsmoking women's answers regarding the amount of saturated fat that they consumed and their rate of lung cancer, isn't that true?
A They found that association. They found there was a fat association amongst many associations that they looked at.
Q And they found that it was statistically significant?
A Yes, indeed.
Q And that at least raises an hypothesis that saturated fat intake can cause or be related to lung cancer?
A It raises a hypothesis, it's not one that is very attractive on the basis of general knowledge, but it is one that's worth testing.
Q Now, industrial exposures can also be a

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cause of lung cancer, can't they?
A There are many occupational causes that have been shown to cause lung cancer.

EXAMINATION

BY MR. MUNSON:
Q You agree, do you not, Doctor, the mechanism of cancer is not yet known?
A I have to qualify that. Part of the mechanism is known, the complete mechanism is not yet known. We know a lot about the mechanism now.
Q Let me show next our company copy of Exhibit 5 from this deposition, which is your draft article entitled Uncovering the Effects of Smoking Historical Perspective.
A Yes.
Q And then there is a sentence after that that reads: "The conclusion that cigarette smoking was a major cause of disease had not been easy to reach as it had not been possible to prove causation by experiments in humans, nor to produce comparable disease experimentally in animals."
A Yes.
Q Did I read that correctly, sir?

A You did.
Q You wrote those words in this draft --

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A Yes.
Q -- article of yours, correct?
A Correct.
Q Thank you, sir.
A This, of course, was referring to the early 1950s. This paper, Uncovering the Effects on Smoking?
Q Yes, sir.
A Uh-huh.
Q On page one, there's a heading in the upper left-hand side that says Introduction.
A Yes.
Q And the first sentence under introduction introduction reads: "Tobacco gross naturally in Central America and the pleasant effects of burning the leaves and inhaling the smoke was discovered by the Mayans some 2,500 years ago," correct?
A Yes.
Q And then the next paragraph which begins about two-thirds the way down the page reads: "The smoking of tobacco for pleasure became a common habit for those who could afford it only in the last quarter of the 16th Century initially in Britain where it was popularized by Sir Walter Raleigh among others, and subsequently at the beginning of the 17th Century, in the Netherlands."

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A Yes.
Q "Many, however, thought that smoking was a dirty habit and use of tobacco was virulently attacked. In Britain the opposition was lead by King James the 6th of Scotland when he succeeded to the throne of the United Kingdom as James the 1st in 1603, and he published a pamphlet against it in Latin in the same year and in English under the title of a Counterblast to Tobacco, a year later. The pamphlet was read widely, dutifully praised, and generally ignored." Did I read that correctly?
A Not quite, you put in an extra king, but otherwise it was correct.
Q I apologize.
A Not at all.
Q Okay. But other than that, did I read it correctly?
A Yes.
Q Thank you.

EXAMINATION

BY MR. MOTLEY:

Q Dr. Doll, do you know whether or not by 1958 benz(a)pyrene had been identified as an animal carcinogen?
A I am certainly confidence that it been. I

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worked very closely with Sir Ernest Kennaway and his group was one that identified it in tobacco smoke and he was looking for it specifically because of his knowledge of it being -- of it as an animal carcinogen.
Q Doctor, do you believe that benz(a)pyrene, in fact, was able to be removed from cigarette smoking that that should have been done?

A If it were possible to do it, yes.
Q Now, Doctor, you were asked questions on Friday about whether or not you would accept observations and comments from myself, a lawyer, or from Mr. Grossman, a lawyer, in regard to the historical review article that you were being questioned about; do you recall that?
A Yes, I do.
Q Doctor, would you accept from me or Mr. Grossman or anyone else a suggestion that you changed scientific findings of a study that you conducted?
A No. I would accept suggestion that I should look into something, that I should check the validity tie of what I said, I would accept that suggestion from anyone, as I always want to improve my articles and I would never reject a suggestion without considering it. But whether I would -- whether I

would act on it would depend entirely on my scientific judgment.
Q Well, sir, do you accept arguments from lawyers that you should change the scientific findings of a study because it was in the financial interest of the company that their attorney worked for --
MR. GROSSMAN: Objection to the form of the question.
Q Sir, would you accept instructions or advice from a lawyer representing a company with a financial interest in a product that you change or suppress a scientific finding that you had made?
A I certainly would not.
MR. GROSSMAN: Same objection.
MASTER RUTTER: Overruled.
Q You would what, sir?
A I certainly would not.
Q Doctor, you were asked questions about diet by the tobacco company's lawyer; saturated fat, diet, diesel fumes, coal tar, air pollution, cooking with a wok, family history and socioeconomic status; do you recall that?
A Yes, I do.
Q Do any of those circumstances alter your opinion on lung cancer caused by cigarette smoking?

A Not the least.
Q Explain why.
A Some of the relations that were suggested to me that were correlated with those particular habits are unproven, and all of them that are demonstrated are very small and work in synergism with smoking, so they have no effect at all on the conclusion about the harmful affects of cigarette smoking.

EXAMINATION

BY MR. GROSSMAN:
Q So it's your view that the science article on benz(a)pyrene does not establish that the chief toxin in cigarette smoking, the principal cause that can be attributed to the increased risk of lung cancer or other diseases in the public is bynz(a)pyrene?
A Nobody ever suggested it was, let alone the authors of that article. They merely suggested that that was a contributory cause and they showed how it could cause them.

Q How it could, correct? And you don't believe that there is even enough benz(a)pyrene in cigarette smoke to account for the observed increase in risk, isn't that true?
A I certainly believe there is enough to account for some increase the risk, but not enough to

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account for it all.

EXAMINATION

BY MR. HURWITZ:

Q Doctor, this document was written in 1958 as we know. Do you recall at this time whether it was common knowledge among scientists in your field that benzopyrene was present in cigarette smoke?
A Yes.
Q And, in fact, there were many published articles reporting the existence of benzpyrene in cigarette smoke?
A There weren't many, but there were some.
Q But you know that in --
A I knew that.
Q So the fact that there was benzpyrene discussed in this document wasn't something that scientists were unaware it, that benzpyrene was --
A No, they should be aware of it.
Q Doctor, you testified at your deposition that benzpyrene by itself could not be responsible for the observed increase in lung cancer; isn't that correct?
A That is correct.

EXAMINATION

BY MR. GROSSMAN:

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Q And do you agree with the statement that you made at that time that most epidemiological research is observational in character rather than experimental and the interpretation of its results is correspondingly difficult?
A Yes, I do.
Q Doctor, let me hand you what's been marked for identification purposes as Defendant's Exhibit No. 4, which is a work caused the Causes of Cancer: Quantitative Estimates of Avoidable Risks of Cancer in the United States Today, by Doll and Peto, from the Journal of the National Cancer Institute in June of 1981. Are you -- you recall having written that report --
A I do.
Q -- with Mr. Peto? Doctor, I'd like to direct your attention to page 1293, footnote 1. And that deals what recall bias.
A Okay.
Q I'd like to direct your attention to footnote 1 in the lower left-hand column, and I'll read it. It says: "Questionnaires seeking recall of quantitative smoking habits in the distant past are notoriously unreliable, and even questionnaires about current habits may be subject to large errors. For

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example, data from four large questionnaire based surveys suggest a 15 percent reduction between 1964 and 1975 in the number of cigarettes smoked per U.S. adult, but this reduction is probably chiefly due to

progressive increases in underreporting because no such large trends are evident and more reliable data on the number of cigarettes actually manufactured. By 1975, 50 percent more cigarettes were being sold than the questionnaire surveys indicated were being smoked."

A Yes.

Q Do you recall the data underlying that footnote?

A No, I don't. There is a reference to Warner '78 but we did check it at the time, and I stand by the footnote.

Q All right. And in your own work on smoking and health and in your own writings in the field, you have noted that prior to 1950, the number of people who were said to have died as a result of lung cancer is -- present very questionable statistics because of the poor diagnostics of the period, the lack of x-rays in the beginning of the century, the development of bronchoscopy only toward the mid century and a variety of other factors; isn't that correct?

A Yes, indeed, because we had to demonstrate that in order to disprove some claims through the tobacco industry which were saying that smoking could not have caused lung cancer because the mortality rate had increased so much more than the amount of consumption, and Dr. Todd wrote a paper and argued that very strongly. It finally went to a committee which was chaired by the government actuary, I think, and the British tobacco industry entirely failed to take into account that there had been artifactual increase in the number of lung cancers -- in the diagnosis of the lung cancer.

Q So it's been your belief for some time and it remains your belief now that lung cancer statistics before 1950 are certainly untrustworthy, notoriously unreliable?

A I may well have used that word, but it doesn't mean to say they have no value, it just means that they have to be used in great care.

Q And you're aware of various studies have shown on autopsy that diagnoses made in life were very often wrong?

A Sometimes. There is a great misunderstanding about this frequency which areas are recorded at autopsies. It depends on how fine you

make your diagnosis.

In fact, the clinical diagnosis of cancer are nearly all correct, there's a small proportions are not, but if you -- if you do detailed studies in autopsy and hospital records, you can present it in such a way as to make it appear 50 percent of your hospital diagnoses are wrong, but that's by taking some minute share of the diagnoses and show that's not confirmed.

Q The broader the criteria used, the -- let me rephrase the question.

There are studies regarding misdiagnosis of primary site of cancer?

A Yes.

Q Misdiagnosis of cancer itself?

A Yes.
Q Failure to diagnosis cancer?
A Yes.
Q Interobserver variations where two different --
A Autopsy?
Q -- two different -- two different pathologists come to different conclusions as to the cause of death?
A As to the site of origin or as to the

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histology, they wouldn't come to different conclusions about it being cancer or not. Except in some of these borderline conditions like one has now in breast cancers where really every little, tiny lump has to be removed and the question of whether it's malignant or not or whether it's a benign lump is subject to difference, but the condition which causes death you don't get significant variation between pathologists.
Q Between pathologists at autopsy?
A No.
Q Is that correct?
A Yes.
Q Okay. You're aware, though, that studies have been done both interobserver and intraobserver variation in the review of pathological materials?
A Yes, indeed, however, I'm trying to make the point that these don't affect the major diagnostic criteria of conditions that cause death.
Q Now, are you familiar with studies that have been done by the Royal College of Physicians and Surgeon in London and the Royal College of Physicians and Surgeons in England on autopsy and audit of autopsies?
A Some of them.
Q They have found a fair degree of

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misdiagnosis of primary site of cancer on autopsy, have they not?
A Yes. I would like to be reminded of the data, because it's not a major difference of the major cancers.
Q All right. There is also a criteria that -- then there is also something that is referred to in literature as the occult or silent cancer; is that correct?
A Yes.
Q And very often at autopsy a cancer is discovered that was not known during the life of the person?
A And quite probably would have made no difference if it had been discovered. It has no affect on the person's life expectancy.
Q All right.
A It particularly true of prostate, of course.
Q You said earlier that smoking is neither the necessary nor sufficient cause of any major disease.
A Yes. No, no, I didn't. I said it was the necessary cause of true diseases. I said it wasn't both the necessary and sufficient cause of any disease.
Q And you said It's not -- it's not the

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necessary and sufficient cause of any disease and it's neither necessary nor sufficient for any --

A For any --

Q -- for any major disease including any form of cancer and any form of pulmonary disease and any form of heart disease apart from tobacco angina?

A Yes.

Q Now, the -- given the fact that cigarette smoking is either a necessary nor sufficient cause of any of those diseases, one cannot prove that any particular individual's disease was caused by smoking through the use of epidemiology; is that correct?

A One can only give a probability that it was caused by smoking.

Q Epidemiology relates to large populations rather than to individuals?

A No, no. The data from the large populations definitely apply to individuals, so that I can give you -- if you tell me what your past smoking history has been, I'm assuming that you're not smoking now, I can give you an indication of the probability if you develop lung cancer that that will be due to a past smoking history.

Q Now, Doctor, with regard to those various diseases -- well, let me rephrase that. Even with

those diseases, there are a number of unsolved puzzles, correct?

A The number of unsolved puzzles relates to every disease.

Q All right. Science does not know why some people who smoke a long time get squamous cell carcinoma and others get small cell; is that correct?

A Yes.

Q Similarly, science doesn't know why some people who smoke don't get lung cancer while others who do, do get lung cancer?

A Well, I don't think that is correct. I think we do know. But it is very difficult to put this over to non-epidemologists, but if you will allow me a moment, sir, to explain it?

Q Certainly.

A I think the principal reason is chance. Now, if you stop and think for a moment, when a cancer develops in a cell, the stem cell in the bronchial mucosa, let's say that is treated and cured, is sometimes cured, what happens to all the other cells in the bronchial mucosa? Those have the same genetic susceptibility, the same DNA, they been exposed to the cigarette smoke in the same way, but it doesn't have cancer in 10,000 cells, the cancer develops in one

cell, and that is because half a dozen things have happen in that one cell that results the production of a cell which escapes from the control mechanism in the body that normally stops it form multiplying. But all the other cells have had exactly the same exposures, the susceptibility as the one that has turned into cancer. Why has he had cancer in that cell and not in the others? But chance.

Now, if that is so and there were 10,000 cells which could have been affected -- I can't swear to that number, it might be 5,000, it might be 50,000,

I don't know, but the large number of stem cells in the bronchi, if only one of them has turned into cancer, surely it's not surprising that in you you've got one which has turned into cancer but I haven't got one that has turned into cancer although we've had exactly the same exposure.

Q Chance plays a large part?

A Chance plays a very important part in determining that one person gets cancer and another person doesn't.

Q And one cannot predict in advance because of large play a chance which concern will get cancer and which one won't?

A No, you can't.

Q Similarly, looking retrospectively, one cannot say why one person got cancer and another person didn't --

A I must go --

Q -- except to say that cancer had a role?

A One must -- I must go back to your previous sentence -- question because I gave the wrong answer. There are some examples where you can say because of a high susceptibility that that's why the person got it. What that usually means is that one of those changes which are required to turn a normal cell into a cancer cell was present at birth in all the normal cells and so that person is much more likely to get it. So there are some people that you can say, yes, they are much more likely to get the disease. But for the vast majority of people, the principal reason why one gets it and the others don't is chance.

(At this time the videotape of Dr. Doll was concluded.)

THE COURT: That concludes the video. Very well then, we'll be in recess until tomorrow morning at nine.

(The proceedings were adjourned at 5:20 p.m.)

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